



August 2003

New power technologies clear path to tactical directed energy weapons

by Michael Kelly, Propulsion Directorate

WRIGHT-PATTERSON AIR FORCE BASE, Ohio — Air Force Research Laboratory's Propulsion Directorate experts are helping power the American military structure as it transforms. Through their work in advanced electrical power and thermal management technologies, Propulsion Directorate experts are developing technologies to power concepts like high-power laser weapons on fighter aircraft, electronics-attacking microwaves and non-lethal technology that uses electromagnetic energy to stop an advancing adversary.

According to Rick Fingers, deputy for technology in the directorate's power division, recent advancements have been made in several areas addressing the challenges of supporting these futuristic weapons. The directorate's work is an outgrowth of the "more electric aircraft" program, which began as a thrust to develop electrical power technologies that replace aircraft hydraulic systems.

"One of the future's significant transformational technologies is adding directed energy weapons to the warfighter's arsenal," Fingers said. "The whole fervor for directed energy has blossomed as a result of power technologies and we're excited about our work in the directorate cutting that path into the future."

Directorate scientists and engineers have been on the ground floor of this enterprise, keeping a keen eye on where to focus their efforts. Developing a new class of higher operating temperature electrical components such as switches and capacitors along with super-conductivity and thermal management technologies was high on their list. All have shown tremendous progress, he said.

Researchers involved in developmental testing diamond-like Carbon Capacitors say their progress is the most significant in decades.

"Our team of scientists and engineers has enabled the production of capacitors with improved energy density and temperature capabilities that are more than two times better than today's state-of-the-art capacitors," said Sandra Fries-Carr, manager for the DLC capacitor program in the electrical technology and plasma physics branch.

Capacitors, which store an electrical charge, are critical components in nearly every military and commercial high performance system, she said. The improvements are crucial for airborne applications of directed energy weapons because they offer considerable savings in system weight, improved electrical performance and can withstand the types of high temperatures generated by the power systems feeding the electrically-driven weapons.

Another key enabling technology needed to develop Air Force directed energy weapons is a high temperature superconducting wire dubbed YBCO, for its molecular configuration of Yttrium, Barium and Copper Oxide.

The YBCO conductor is the next generation high temperature superconducting wire necessary for developing directed energy weapons, said Dr. Paul Barnes, a senior physicist and propulsion directorate superconductivity team leader.

"The need for compact, lightweight, high power generators and magnets is critical to quite a few defense applications," said Barnes. "A newer superconductor was needed that could operate at higher cryogenic temperatures to reduce the cooling requirement."

According to Barnes, by using YBCO conductor technology, high speed and high temperature superconducting generators can produce megawatts of electrical power while weighing up to 80 percent less than traditional iron-core generators. These size and weight reductions enable high power dependent weapon systems on air or mobile platforms, he said, opening the door to airborne applications such as directed energy weapons.

Electrical DEWs, which include the solid-state, high-energy laser and most high-power microwave

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sources, emit radiation energized by onboard electrical power.

“In fact, we plan to generate sufficient electrical power for the airborne DEW design concept by coupling a rotating electrical generator to the aircraft turbine engine,” explained Scott Rubertus, deputy chief of the power division.

The new power generators would allow the electrical DEW to operate as long as jet fuel is available to turn the turbine engines providing a “deep ammunition magazine,” he said. Aerial refueling would eliminate the requirement to land and rearm the aircraft in a conventional sense.

In contrast, the airborne laser platform uses a chemically fueled laser to shoot down ballistic missiles while they still are over an enemy’s own territory. When chemical reactants are expended, the aircraft must return to base for “re-loading.” @